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Original article

Experience with laparoscopic sleeve gastrectomy for morbid obesity in a general hospital

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Abstract

***Objective*:** The purpose of this study is to examine the outcome of laparoscopic sleeve gastrectomy (LSG) for morbid obesity.
***Method*:** We examined the treatment results of patients who underwent SLG at our hospital. The items to be examined included postoperative weight changes and obesity-related complications (type 2 diabetes, hypertension, dyslipidemia).
***Results*:** The subjects were 33 morbidly obese patients (8 males and 25 females) who underwent LSG from August 2014 to February 2020. The mean age at the first visit was 44.0 ± 3.5 years (20-65 years), the mean weight was 107.9 ± 7.6 kg (85-142 kg), and the mean body mass index (BMI) was 41.5 ± 3.3 kg/m^2 (35.3-52.6 kg/m^2). No postoperative complications were observed in all cases. The weight reduction effect in the first year after surgery was 34.8 ± 10.2 kg (11.2-53.3 kg), the mean BMI reduction was 13.9 ± 3.7 kg/m^2 (4.5-20.0 kg/m^2), and the mean percentage of excess weight loss was 84.8 ± 20.7% (38.9-143.0%). Metabolic disease remission rates were 93.3% in type 2 diabetes, 65.2% in hypertension, and 60.0% in dyslipidemia.
***Conclusion*:** The results of LSG were as good as those of other institutions in terms of weight reduction and improvement of obesity-related diseases.

***KEY WORDS*:** morbid obesity, weight reduction before surgery, laparoscopic sleeve gastrectomy, bariatric surgery

Introduction

According to world statistics, the population with a body mass index (BMI) of 25 kg/m^2 or higher was 860 million in 1980, in 2013 it surged to 2.1 billion, and human beings continue to gain weight on a global scale [1]. It is estimated that 3.4 million people died of obesity in 2010 [1], and continued obesity leads to increased mortality [2, 3]. Obesity also causes complications including type 2 diabetes mellitus (T2DM), hypertension, dyslipidemia, sleep apnea syndrome, fatty liver, knee osteoarthritis, and low back pain. Furthermore, it is a factor that increases the risk of cancer [4]. If diabetes becomes chronic, it will lead to a decrease in quality of life (QOL), *i.e.* dialysis, blindness, and amputation of the lower limbs, and medical expenses will inevitably rise. In order to extend healthy life expectancy and control medical expenses, the treatment and measures to suppress the progression of metabolic domino [5] are required. Traditional therapies including diet, exercise, drug, and behavior interventions have been performed, and in recent years, surgical therapy has been added as one of the treatments for obesity.

It is often difficult to obtain long-term weight reduction effects with medical treatment for morbid obesity with a BMI of 35 kg/m^2 or higher, however, it has been found that surgical treatment has a long-term weight reduction effect [6, 7, 8]. Surgical treatment for obesity, bariatric surgery, has been performed in Europe and the United States since the 1960s. Then, with the increase in the obese population and the establishment of the safety of laparoscopic surgery, bariatric surgery has rapidly become widespread. The number of bariatric surgeries performed worldwide was 150,000 in 2003, 340,000 in 2011, and reached 470,000 in 2013 [9].

On the other hand, bariatric surgery has not been generalized in Japan. However, facing the increase in the number of morbidly obese people and knowing the success of bariatric surgery in Europe and the United States, laparoscopic sleeve gastrectomy (LSG) was certified as an

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advanced medical treatment in 2010 and covered by insurance in 2014. Nowadays, the number of bariatric surgeries is increasing every year. Since it seems that our hospital is the first to introduce bariatric surgery in Kyoto prefecture, here we report on the launch of bariatric surgery in this area and the results of obesity surgery performed in our hospital.

Methods

Launch of bariatric surgery

In 2009, we started to devise a plan for the introduction of bariatric surgery and collected a lot of information regarding this surgery. In 2012, an obesity treatment team was set up with a focus on surgical treatment. We visited medical facilities with abundant experience in bariatric surgery, gained experience, sent surgical cases to them, and tried to master the procedure of patient selection, preoperative preparation, and postoperative follow-up. Concurrently, we participated in academic meetings and seminars for obesity treatment as an obesity treatment team and worked to share the knowledge of the team. It was approved by the ethics committee of this hospital and conformed to the facility standards, followed by an application to the Ministry of Health, Labor and Welfare and reception for facility certification. In 2014, LSG began to be covered by medical insurance and we opened an outpatient department for bariatric surgery. The first LSG was performed in August 2014, almost two years after the team was launched. Around the same time, we opened a homepage and conducted public relations activities in the media and medical associations.

Subjects

Of the 123 patients who visited our outpatient department of obesity surgery, we selected 33 patients (26.8%) who met the insurance coverage requirement, indicated below, and received LSG. Japan's insurance is applied to patients who meet the following three conditions; firstly, medical treatment for 6 months or more does not provide sufficient effect; secondly, BMI is 35 kg/m^2 or more; thirdly, those who are accompanied with one or more of diabetes, hypertension, dyslipidemia, and sleep apnea syndrome. The male-female ratio is 8 males and 25 females, the mean age is 44 ± 3.5 years (20-65 years), the mean weight is 107.9 ± 7.6 kg (85-142 kg), and the mean BMI is 41.5 ± 3.3 kg/m^2 (35.3-52.6 kg/m^2). The obesity-related complication rates were 54.5% (18 cases) in diabetes, 81.8% (27 cases) in hypertension, 93.9% (31 cases) in dyslipidemia, and 45.5% (15 cases) in sleep apnea syndrome. Other complications were fatty liver in 25, depression in four, mental illness in three, cerebral infarction in one, cerebral hemorrhage in one, heart disease in two, and borderline diabetes in two. One patient rebounded and underwent re-sleeve surgery.

Surgical technique [10]

LGS is a surgery method to remove the side of the greater curvature of the stomach and create a banana-shaped stomach. All surgeries are conducted by the laparoscopic five port approach in the position with the head up in order to reduce the burden on the lungs. Separate the greater omentum along the stomach wall in the cranial direction, using an ultrasonic coagulation incision device. Separate the greater omentum up to the His angle at a proximal part of the stomach and up to about 4 cm from the oral side from the pyloric ring at a distal part. Ask a gastroenterologist to insert an endoscope up to the pyloric region, and fixate it at the side of the lesser curvature. The endoscope can be followed as a guide to cutting off the stomach using an autosuture. Reinforce the staple line by continuous suture using 3-0 absorbing thread. Confirm the presence or absence of constriction and bleeding and that the stapler does not become lodged in the esophagus. Retain the drain along the cutting line of the stomach.

Ethical standards

Before the surgery, written informed consent was obtained from the patients. This study was implemented in compliance with the Helsinki Declaration (as revised in 1975 and 1983) and was approved by the hospital's ethics committee.

Results

The surgical results of LSG in our hospital are shown below.

No postoperative complications were observed in all cases. The body weight decreased from 107.9 ± 7.6 kg before surgery to 73.1 ± 9.7 kg one year after surgery, and the mean weight loss was 34.8 ± 10.2 kg (11.2-53.5 kg). BMI decreased from 41.5 ± 3.3 kg/m^2 preoperatively to 27.6 ± 2.8 kg/m^2 after surgery, and the mean decreased BMI was 13.9 ± 3.7 kg/m^2 (4.5-20.0 kg/m^2). Excess weight decreased from 42.9 kg ± 13.0 kg preoperatively to 6.8 kg ± 7.4 kg after surgery, with the mean percentage of excess weight loss of 84.8 ± 20.7% (38.9-143.0%). Here, the percentage of excess weight loss was calculated as the weight when the ideal weight was 25 with a BMI.

The remission rate of metabolic diseases 1 year after surgery was 93.3% for T2DM, 65.2% for hypertension, and 60.0% for dyslipidemia. ***Figure 1*** compares the percentage of excess weight loss of 46,133 LSG cases performed by 130 surgeons worldwide with the results of our hospital [11].

Discussion

In starting bariatric surgery, we aimed to eliminate complications. We started bariatric surgery with the intention of stopping the surgery if complications occurred. Once started, we decided to continue the surgery. Fortunately, there were no postoperative complications. In the case of LSG, possible early postoperative complications include postoperative hemorrhage, anastomotic insufficiency, wound infection, and stenosis of gastric tracts. According to a questionnaire survey in Japan in 2020, the incidence of postoperative complications of LSG in 2,867 cases was

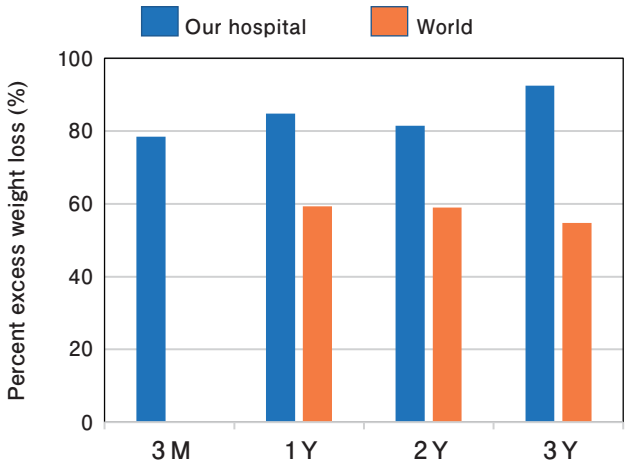

Fig. 1. **Percentage of excess weight loss after LSG in our hospital and the world.**

Our hospital, n = 33. World, n = 46,133, a total number of LSG cases performed by 130 surgeons. Percentage of excess weight loss is calculated with the below formula:
Percentage of excess weight loss = [(preoperative BW – postoperative BW) / (preoperative BW–Ideal BW)] x 100. Ideal BW was calculated by BMI = 25; BMI, body mass index; LSG, laparoscopic sleeve gastrectomy; BW, body weight.

0.7% for hemorrhage, 0.5% for sutural insufficiency, 1.2% for wound infection, and 1.1% for gastric stenosis. In the foreign literature on LSG in 900 cases [12], complications were hemorrhage 0.4%, sutural insufficiency 0.8%, gastric tract stenosis 0.7%, wound infection 0.1%. In another report of 940 cases [13], hemorrhage was 3.57% and sutural insufficiency was 1.17%. And in the 2016 European review [14], hemorrhage was 3.6% and sutural insufficiency was 0-3.7%. It seems that sutural insufficiency and hemorrhage tend to be less common in Japan. We believe that the key to eliminating complications is preoperative weight reduction and ingenuity during surgery.

Weight reduction before surgery

Patients' weight had rebounded repeatedly. If bariatric surgery had not been conducted at the point of achievement of preoperative weight reduction by medical treatment, we expect that their weight would have rebounded again. The purpose of bariatric surgery is not only to achieve weight reduction, but also to change the patient's body so that it is hard to gain weight. Motivation is important for treating obesity. Patients had a clear purpose for losing weight; *i.e.*, to be able to undergo bariatric surgery, and focused on achieving steady preoperative weight reduction within a short period of time. Patients that can decrease their body weight are selected for bariatric surgery because it is judged that they would be able to withstand more severe postoperative diet control. To conduct bariatric surgery safely, it is important to reduce the quantity of visceral fat so that the lateral segment of the liver, which undergoes compensatory hypertrophy in the presence of fatty liver, can be reduced as much as possible.

Ingenuity during surgery

The surgical position was a beach chair position with high-head, thus reducing the burden on the lungs and facilitating postoperative management. The most troublesome postoperative complication is probably sutural insufficiency [15-17]. Suture failure in LSG is difficult to cure and resists treatment for a long time. The most common part accompanied with sutural insufficiency is the esophagogastric junction. Therefore, an automatic suture device with reinforcement was used for gastric dissection. The His angle is cut at a site 1 cm away from the joint, and a seromuscular suture is ligated to reinforce the dissection surface, thus forming a thin gastric tube. Reinforcement is started from the His angle, and seromuscular sutures are added continuously to the nodule, then concurrently adding seromuscular sutures or full-thickness sutures from about half of the cut surface to the anal side. There is expected to be no postoperative pain when the muscle layer is closed and sutured from the inside of the abdominal cavity. For preventing hemorrhage, the manipulation around the spleen was performed carefully and cautiously. This is because it is difficult to stanch the bleeding in spleen injury.

Laparoscopic sleeve gastrectomy (LSG)

The characteristics of LSG are comparatively simple and clear, and compared with bariatric bypass surgery, it has few complications after surgery. Its weight reduction effect can be expected enough that it is said to be better suited for cases that are more likely to be complicated with the disorders associated with obesity despite a low degree of obesity, like that of the Japanese.

Generally, it is understood that creating a banana-shaped stomach is aimed at restricting the intake of food and losing weight, but it is said that an appetite stimulating hormone called ghrelin is secreted in a large amount at the stomach fundus, so appetite can be reduced if it is removed. Ghrelin is also the hormone restricting the secretion of insulin, which suggests ghrelin's involvement in the mechanism of the amelioration of diabetes [18, 19]. Recently, attention was paid to the fact that blood bile acid increases after LSG surgery and in research conducted by a group of Seeley RJ, it was found that, in an experiment using SG mice, the activities of farnesoid X receptor (FXR) were enhanced and large changes in metabolism, such as glucose tolerance, occurred [20]. A mechanism that brings about changes in bacteria in intestines was presented [21]. In this research, the experiment used genetically modified FXR knockout mice and showed that the increase of bile acid was more essential than diet restriction effects because FXR knockout mice following SG did not show weight reduction effects. It is reported that similarly to the case of bypass surgeries, the increase of incretins, such as glucagon-like peptide 1 (GLP-1), were observed even after LSG [22].

Results of LSG

As shown in ***Fig. 1***, the postoperative effect of weight reduction was comparable to that of 46,133 LSG cases performed by 130 surgeons around the world [11]. In a

prospective randomized multicenter study, the effects of LSG on improving complications were 60.0% for T2DM, 65.2% for hypertension, and 43.8% for dyslipidemia [23]. According to the results of LSG conducted at nine centers in Japan, the remission rate of obesity-related metabolic diseases was 85% for T2DM, 66% for hypertension, and 63% for dyslipidemia [24]. According to a latest report [25] dealing with the large number of LSG cases in Japan (322 cases), the complication improvement rate was 75.6% for T2DM, 41.8% for hypertension, and 59.7% for dyslipidemia. It seems that the results of our hospital are not inferior to those of other facilities. Compared to Europe and the United States, Japanese subjects were considered to have a higher rate of remission by LSG for diabetes.

Obesity is not only a metabolic disease, but also an exacerbating factor for locomotor disorders such as knee osteoarthritis and lumbar joint abnormalities. In a case we encountered, total joint replacement was required for knee osteoarthritis, but the patient with a super-obese BMI higher than of 50 kg/m^2 was at high risk of post-replacement complications. It was predicted that functional recovery could not be expected even after surgery. Therefore, LSG was conducted, and after sufficient weight reduction, knee surgery was performed. This is our experienced case with no postoperative complications and good functional recovery [26].

The following is a case in which a lung mass was accidentally found on computed tomography scan (CT) during preoperative weight reduction for the purpose of LSG [27]. Two and a half months after the LSG was undertaken to reduce the body weight in advance, lung surgery was performed; a rapid intraoperative pathological examination revealed malignancy, therefore a right upper lobectomy under thoracoscopy was performed. If the tumor is diagnosed as malignant, surgery for the malignant tumor will usually be prioritized. The idea of prioritizing bariatric surgery to avoid the risk of morbid obesity and safely performing tumor surgery after weight reduction may be indicated in fairly limited cases, such as early-stage cancer. In this case, CT did not give information to the radiologist whether the small mass in the lung was malignant, and he was instructed to follow up with CT once a month. LSG preceded the lobectomy because there was no change in tumor size, patients were rebounding repeatedly, and there was a high possibility that they would rebound again if they did not undergo bariatric surgery after preoperative weight reduction. As a result, 2.5 months after the operation, upper lobectomy was safely performed without complications. In such cases, LSG appears to be a more suitable procedure because it results in faster weight loss than the use of an intragastric balloon or laparoscopic adjustable gastric banding; involves a simple procedure and a shorter operating time; and causes fewer postoperative complications than bypass surgery, such as laparoscopic Roux-en-Y gastric bypass. LSG might be superior to various other bariatric surgical procedures in terms of its ability to shorten the interval between diagnosis and curative treatment for malignant tumors in morbidly obese patients.

The key to the success of bariatric surgery is a thorough explanation before and after surgery and a management system by team medical care. Namely, the preoperative weight reduction and postoperative follow-up by multidisciplinary treatment of a team, consisting of a surgeon, a diabetologist, a registered dietitian, a physical therapist, a clinical psychologist, a psychiatrist, and a certified nurse, are important. The secret to successful surgery is to explain the meaning of dietary restrictions repeatedly many times and to be fully convinced before surgery. In order to prevent the postoperative rebound, it is important to regularly visit outpatient clinics for follow-up and guidance to continue weight reduction. We experienced a case of a woman with age of 20s who had social psychological problems but succeeded in reducing weight through team medical care [28].

The weight reduction effect of bariatric surgery progresses from half a year to one year, while diabetes progresses to remission about one month after surgery. In daily clinical practice, blood glucose levels normalize one week after bariatric surgery. As can be seen from reports from our hospital or other institutions, it has been reported that the remission rate of T2DM is higher than that of other obesity-related diseases [2,29-33]. When we face to the obesity treatment, it is important to understand that the purpose is not merely to improve the body image of obesity, but rather to restore healthy life expectancy.

Conclusion

An obesity treatment team, centering on surgery, was set up at a regional hospital and probably started the first bariatric surgery in Kyoto prefecture. The results of LSG at this hospital were as good as those of other institutions in terms of weight reduction effect and improvement effect of obesity-related diseases.

Conflict of interest

The authors have no conflict of interest in this work.

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